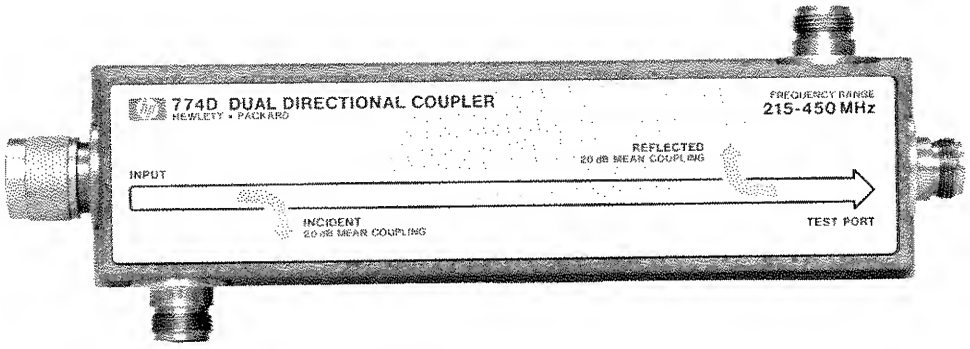
OPERATING NOTE

HP 774D/775D
DUAL DIRECTIONAL COUPLERS



JULY 1986

HEWLETT PACKARD

HP 774D, 775D

DESCRIPTION.

The Hewlett-Packard Model 774D and 775D Dual Directional Couplers are three-port passive devices for use in 7-mm, 50-ohm systems. A coupler is essentially a device for sampling power flowing in one direction in a transmission line. Since no coupler is perfect, some power flowing in the opposite (unwanted) direction is also sampled. The rejection of power flowing in the unwanted direction is called directivity and is the most important specification of a directional coupler. These couplers have 40 dB directivity. Another specification is the forward coupling attenuation (usually called just coupling) which is the fractional amount of power transferred in the wanted direction. These couplers have a nominal 20 dB of coupling. These terms are defined in Figure 1. Figure 1 also shows a typical coupling curve. This curve is not a specification. The specifications are shown in Table 1.

Table 1. Specifications

	HP 774D	HP 775D
Frequency Range:	215—450 MHz	450—940 MHz
Minimum Directivity:[1]	40 dB	
Coupling Attenuation: (each secondary arm)	20 dB (nominal)	
Accuracy of Coupling: (each secondary arm)	Mean coupling level within 0.5 dB of 20 dB	
Max. Coupling Variation:	±1 dB	
Max. Primary-Line SWR:[1] (50-ohm terminations)	1.15	
Max. Auxiliary-Arm SWR: (50-ohm terminations)	1.20	
Primary-Line Power Handling Capacity:	50 watts average, 10 kW peak	
Primary Line Insertion Loss:	≤0.3 dB	≤0.4 dB
Primary-Line Connectors:	Type N connectors, one male and one female[2]	
Auxiliary-Arm Connectors:	Type N female connectors[2]	
Size: (in.)	9-1/16 x 3-1/8 x 1-3/4	
(mm)	230 x 79 x 45	
Weight (net) :	3 lb (1,4 kg)	

[1] Measured with Hewlett-Packard H02-909A (male) or H03-909A (female) termination.

[2] Compatible with connectors whose dimensions conform to MIL-C-39012 or MIL-C-71.

Port Terminology.

The two directly-connected ports (on opposite ends of the coupler) are called the primary-line ports. The coupled ports on each side are called the auxiliary ports. Coupling is in the direction of the arrows on the nameplate. These coupled ports are called auxiliary-line ports.

Accessories Available.

Two shorting connectors, Hewlett-Packard Model 11511A Type N female short and Model 11512A Type N male short, are available as accessories.

INITIAL INSPECTION.

Mechanical Check.

If damage to the shipping carton is evident, ask that the carrier's agent be present when the coupler is unpacked. Inspect the parts for mechanical damage, such as scratches or dents. Also check the cushioning material for signs of severe stress (compacting).

Electrical Check.

The electrical performance should be verified as soon as possible after receipt. Refer to the performance test for further information.

Claim for Damage.

If a coupler is mechanically damaged or fails to meet specifications upon receipt, notify the carrier and your nearest Hewlett-Packard Office immediately (a list of Hewlett-Packard offices is at the end of this operating note). Retain the shipping carton and the padding material for the carrier's inspection.

REPACKAGING FOR SHIPMENT.

Using Original-Type Packaging.

Containers and materials like those used in factory packaging can be obtained through Hewlett-Packard offices listed at the end of this operating note.

If the coupler is being returned to Hewlett-Packard for servicing, attach a tag indicating the type of service required, return address, model number, and serial number. Also, mark the container FRAGILE to assure careful handling.

In any correspondence refer to the instrument by model number and serial number.

Using Other Packaging.

The following general instructions should be used for repackaging with commercially available materials.

a. Wrap the coupler in heavy paper or plastic (if shipping to a Hewlett-Packard office attach a tag indicating the type of service required, return address, model number, and serial number).

b. Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.

c. Use enough shock-absorbing material (3 to 4 inch layer) around all sides of the coupler to provide firm cushion and prevent movement inside the carton.

d. Seal the shipping carton securely.

e. Mark the shipping carton FRAGILE to assure careful handling.

OPERATION.

Precautions.

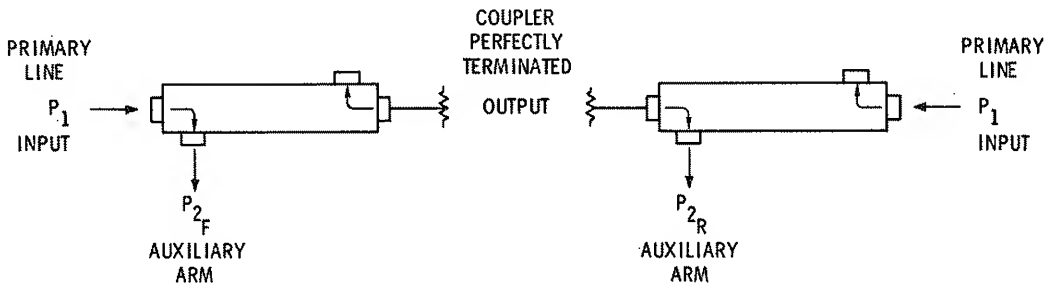
Connectors. The type-N connectors used on these couplers will mate with all other type-N connectors whose dimensions conform to MIL-C-71B and MIL-C-39012. Do NOT mate with the male type-N connector on other 774D's with serials below 3119 or 775D's with serials below 3141 (see caution below).

CAUTION

Do NOT mate with 0.071" diameter pin male connectors. Damage may result.

When installing be sure auxiliary equipment supports its own weight. The coupler, particularly the connectors, is not designed to carry weight.

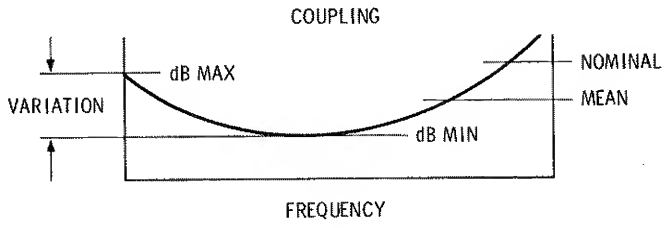
Do Not Drop. Do NOT drop the coupler. While the coupler probably will not break, it can be jarred out of adjustment and the connectors can be damaged.



COUPLING

$$\text{COUPLING} = -10 \log \frac{\text{auxiliary output } (P_{2_F})}{\text{primary-line input } (P_1)} \text{ or } = 10 \log_{10} \frac{P_1}{P_{2_F}}$$

The coupling varies with frequency so the following terms must be defined



DIRECTIVITY

$$\text{DIRECTIVITY} = 10 \log_{10} \frac{P_{2_F}}{P_{2_R}} \text{ (dB)}$$

Terms for the other auxiliary arm may be defined in a similar manner.

Figure 1. HP 774D/775D Coupler Terminology

Ambient Conditions. Do not heat cycle this coupler during use or storage. Keep coupler near room temperature (25°C). Coupler will stand relative humidity of 95% but will be affected by condensation (keep at room temperature).

Signal Flow.

Signal flow is indicated in Figure 1. Coupling is indicated by arrows. These couplers are bi-directional (signal may go through the coupler in either direction).

APPLICATIONS.

Introduction.

These couplers are usually used in a reflectometer. Figures 3, 4, 5, and 6 illustrate typical setups. Note that a line stretcher (or a longer length of cable) must be used with vector voltmeters or network analyzers to balance the two signal paths in the coupler for zero phase reference.

Complementary Equipment. Figures 3, 4, 5 and 6 show Hewlett-Packard model numbers for equipment suitable for use with the 774D/775D couplers.

Error Analysis. There are certain errors present in all reflectometer systems. Usually the most significant error is that caused by the directivity of the directional coupler. The magnitude of this error can be measured accurately over the frequency band (see Directivity Check under PERFORMANCE TEST). Once the directivity is known, the ambiguity of any measurement can be determined with the reflectometer calculator obtainable free from any Hewlett-Packard office (a list of these offices is at the end of this operating note).

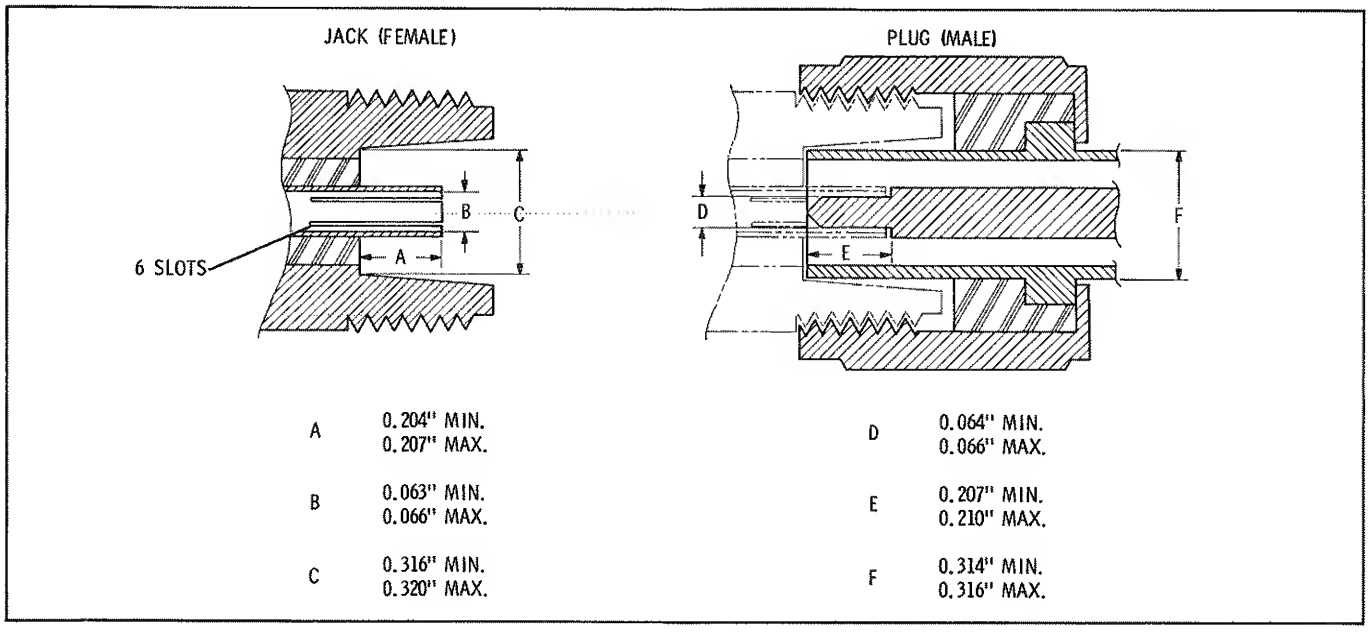
Error also results from multiple reflections or mismatch losses of the components of the reflectometer system. The ambiguity introduced by this error can also be calculated with the reflectometer calculator mentioned above.

For more information on reflectometer systems refer to Hewlett-Packard Application Note 65, obtainable free from any Hewlett-Packard office.

Power Measurement.

The 774D and 775D may also be used for measuring power as shown in Figure 6. Here the coupler samples primary-line power and a coaxial thermistor mount is used as a power-detecting device. The coupler can also be used for measuring peak power up to 10 kW, provided average power remains below the rating of the coupler (50 watts) and the sampled pulses are attenuated to the power-handling capability of the thermistor mount.

When monitoring power with these couplers keep in mind that the output power is the coupling (20 dB nominally) ABOVE the power sampled at the auxiliary port. For very precise work, the insertion loss of the coupler (attenuation of primary line) must be subtracted from the calculated output power.



A	0.204" MIN. 0.207" MAX.	D	0.064" MIN. 0.066" MAX.
B	0.063" MIN. 0.066" MAX.	E	0.207" MIN. 0.210" MAX.
C	0.316" MIN. 0.320" MAX.	F	0.314" MIN. 0.316" MAX.

Figure 2. Dimensions of Type-N Connectors

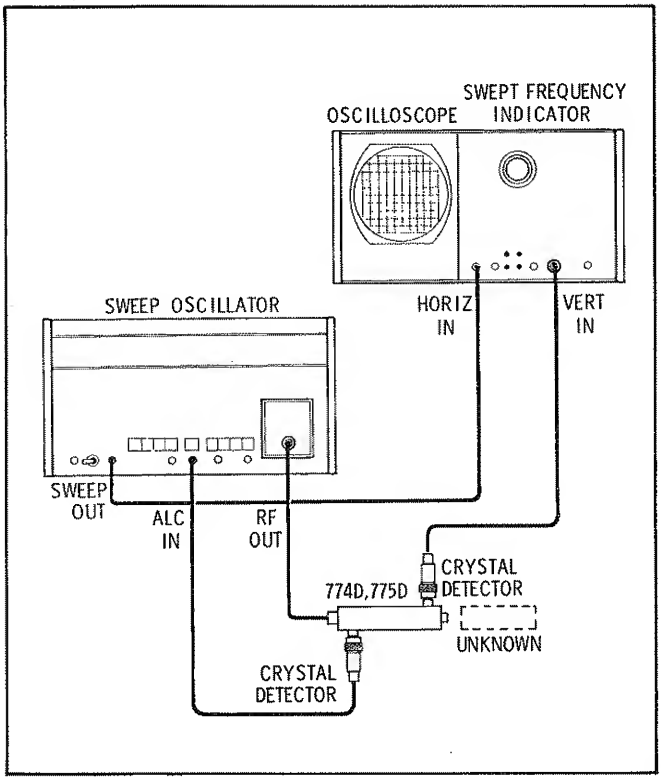


Figure 3. Typical Reflectometry Setup

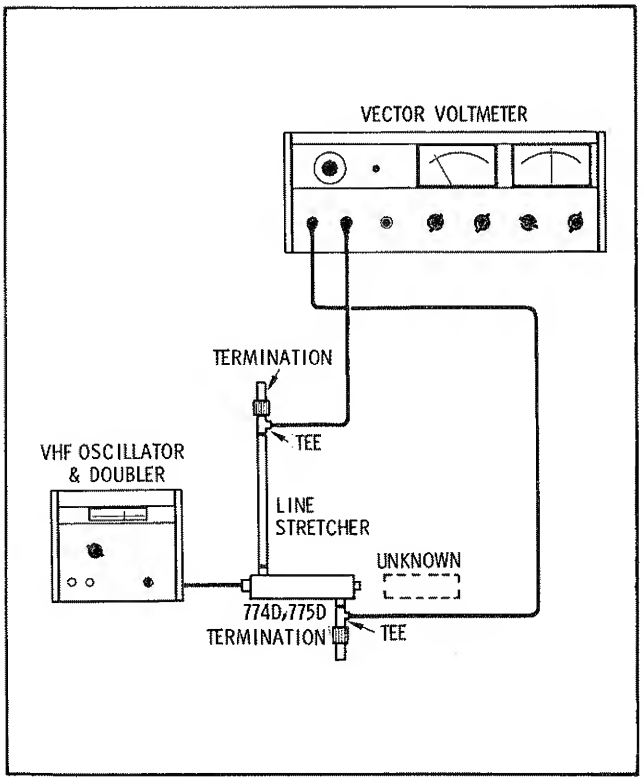


Figure 4. Setup for Impedance Measurement

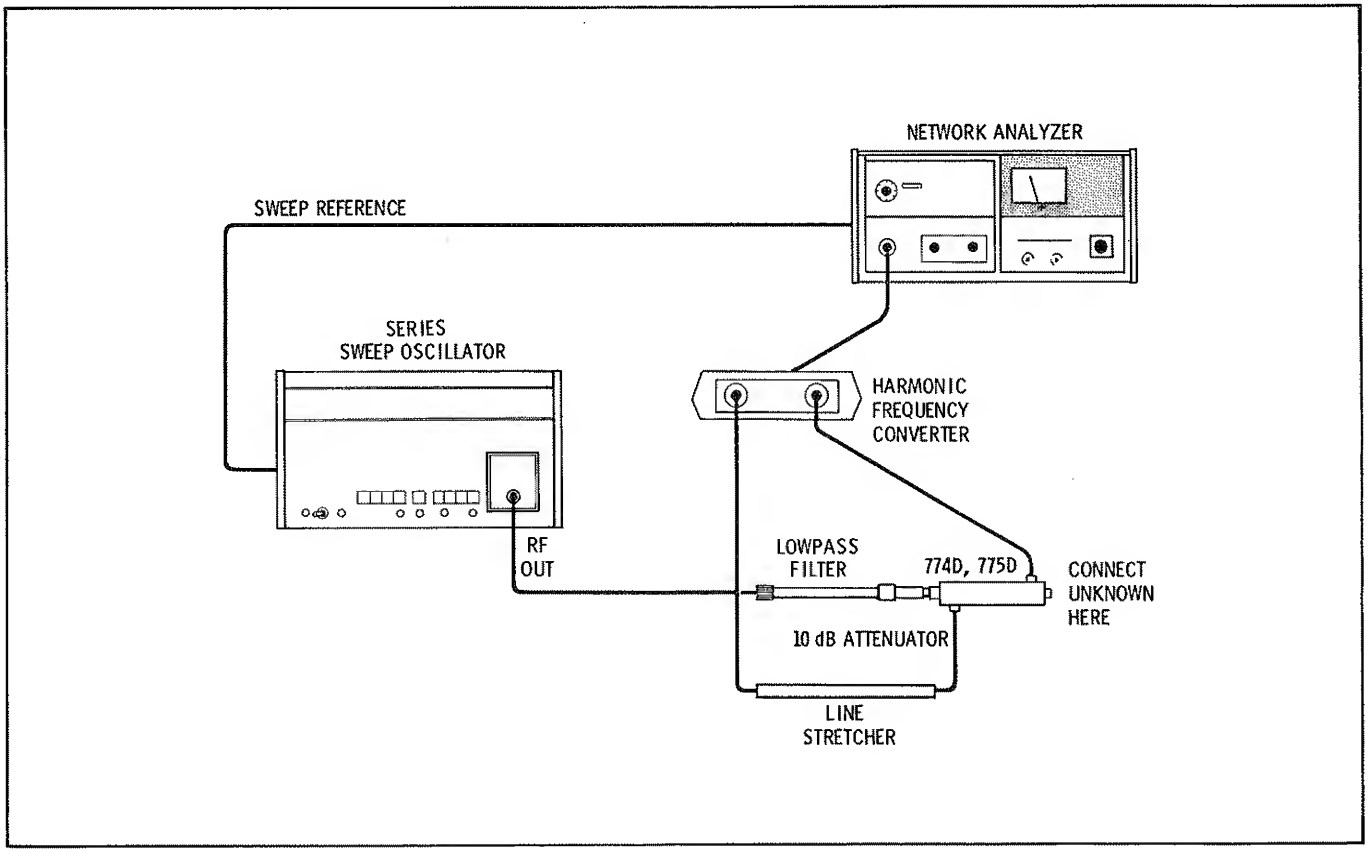


Figure 5. Network Analyzer in Reflectometer Setup

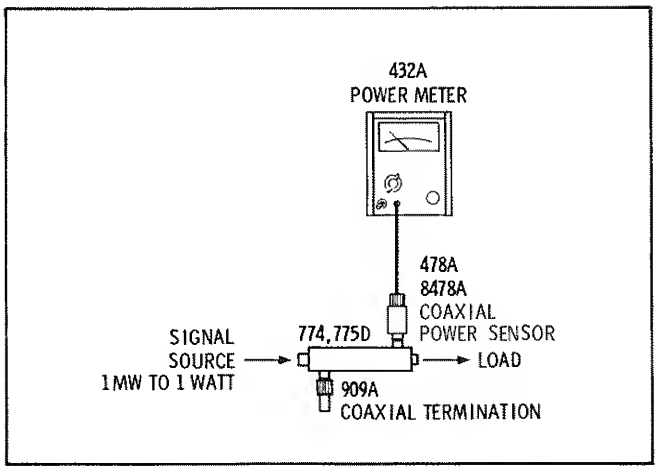


Figure 6. Power Measuring Setup

The couplers can be used not only for power measurement, but for system adjustment for best power transfer as well. This adjustment can be made easily with the setups of Figures 3, 4, or 5. This adjustment can also be made with only a power meter and a coupler. Alternately connect the thermistor mount first to the incident auxiliary arm and then to the reflected auxiliary arm. Connect first as shown in Figure 6. Take a reading, then interchange the thermistor mount and the load and take another reading. Adjust the system for a maximum incident/reflected power ratio.

Power Leveling.

The 774D and 775D can also be used for power leveling, if a single directional coupler is not available. Connect as shown in the left half of Figure 3. Terminate the unused auxiliary arm with a 50-ohm termination.

PERFORMANCE TESTS.

Use the following procedure for initial inspection, performance testing, or whenever the coupler performance is suspected. Table 2 lists the recommended test equipment. Other equipment may be substituted provided its specifications equal or exceed the specifications listed under Critical Specifications. The coupler should be tested on a swept-frequency basis to assure that there are no out-of-specification narrow-frequency bands. The performance test should be done in the order listed. For instructions refer to the Performance Test. Table 3, Performance Test Record, provides a place to record the results.

IMPORTANT NOTE

When a low SWR termination is specified in these tests, the accuracy of the measurement is dependent largely on the quality of this termination. Always use the best termination available. If any of these tests do not meet specifications, consider the ambiguity introduced by the SWR of the termination before rejecting the coupler. Try several terminations before rejecting the coupler. Sliding-load test techniques at single frequencies are not practical due to the low frequencies involved. For these reasons you are urged to test the coupler as soon as it is received with the lowest SWR termination available. If results better than 38 dB directivity are obtained assume the coupler is good. Keep the load separate and use only for this testing. If the coupler is suspected in the future, test for any *change* in the incoming inspection test results. If you get the same results assume the coupler is good. If the results change send the coupler to Hewlett-Packard for repair.

Repair

Do not attempt to repair these couplers. Their high directivity characteristics depend upon the precision with which they are assembled. If a coupler does not meet specifications or is damaged, it should be returned to Hewlett-Packard for repair.

Table 2. Recommended Test Equipment

The following equipment is recommended for testing. Other equipment may be used provided its specifications equal or exceed the specifications listed under "Critical Specifications."

Instrument	Critical Specifications	HP Model No.
Sweep Oscillator	Frequency: band of interest Internal AM: 1 kHz squarewave Power output: >10 mW Power leveling: −V input	HP 8350B with 83522A plug in
Low-pass filter	Rejects: second harmonics Rejection: >40 dB	360A (for 774D) 360B (for 775D)
SWR Meter	Frequency: compatible with sweep oscillator square-wave modulation Accuracy: <0.1 dB error/10 dB	415B/E
Attenuator	Attenuation: 10 dB, 40 dB Frequency Response: ±0.5 dB	8491A/B Opt. 010 (10 dB) Opt. 040 (40 dB)
X-Y Recorder	Impedance: 200K ohms/V Sensitivity: ⩾50 mV /in	7035B
Low-SWR (1) Termination	Frequency: band of interest SWR: 1.01 at frequency tested Coaxial: 50 ohms	H02-909A (type N male) H03-909A (type N female)
Termination (3)	Frequency: band of interest SWR: 1.05 Coaxial : 50 ohms	909A Opt. 012
Dual Directional Coupler	Frequency: band of interest Directivity: >40 dB Nominal coupling: 20 dB	774D or 775D
Crystal Detector	Frequency: band of interest Sensitivity: >4 mV/μW	423A
Oscilloscope, Swept-Frequency Indicator	Vertical Sensitivity: 0.5 dB/cm Accuracy: ±0.02 dB/dB	141T/1416A
Barretter	Frequency: band of interest Response: 0.1 dB/octave	PRD 627AM
Adapter	Male-to-male type N	1250-0778 (UG-57B/U)
Adapter	Female-to-female type N	1250-0777 (UG-29B/U)
Signal Source	Frequency: frequency of interest Internal AM: 1 kHz squarewave Power output: >10 mW	Any sweep oscillator listed above operated in CW
Slotted Line	Frequency: band of interest Residual SWR: <1.04 Impedance: 50 ohms	805C

DIRECTIVITY.

SPECIFICATION:

≥40 dB (774D and 775D).

DESCRIPTION:

Directivity of a coupler is the ratio of power at the auxiliary port when coupler is in forward direction to power at the auxiliary port when coupler is in reverse direction (coupler perfectly terminated each time and same power). The 774D/775D should be swept-frequency tested to be sure that there are no narrow-band out-of-specification points that would be missed with fixed- frequency testing. These couplers will be tested on a swept-frequency basis with a standard reflectometer setup.

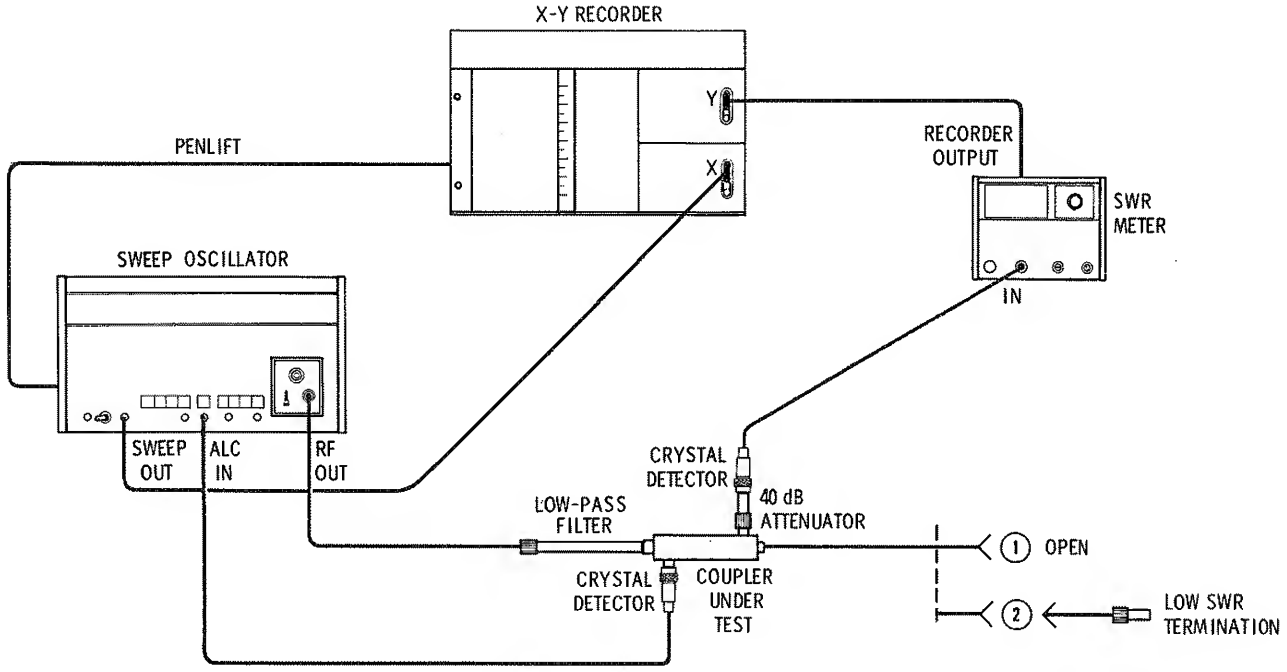


Figure 7. Swept-Frequency Directivity Test Setup

EQUIPMENT:

Sweep Oscillator	HP Model 8350B with HP Model 83522A
Low-pass Filter	HP Model 360A,B
SWR Meter	HP Model 415E
Crystal Detector	HP Model 423A
X-Y Recorder	HP Model 7035B
Attenuator	HP Model 8491A
Low SWR Termination	HP Model H02-909A (type N male); H03-909A (type N female)

PERFORMANCE TESTS (cont'd)

PROCEDURE:

Calibration:

a. Connect equipment as shown at (1) in Figure 7.

b. To calibrate the reflectometer proceed as follows:

1. Set the sweep oscillator to sweep over the band of interest with automatic sweep.

2. Set sweep oscillator for leveled squarewave-modulated output.

3. Set sweep oscillator for manual sweep.

4. Set the SWR Meter to 30 dB or more sensitive range, vary the sweep oscillator RF power to get a reading, and peak the reading with sweep oscillator internal squarewave frequency control.

5. With manual sweep move the X-Y Recorder, with the pen up, throughout the band. Make sure trace will stay on recorder, adjusting X-Y recorder position and gain controls if necessary.

6. Put the recorder pen down and run a trace. This is the calibration trace.

Measurement:

c. To make a measurement proceed as follows:

1. Connect the termination as shown in (2) in Figure 7. Note that this termination must have an SWR $\leqslant 1.01$. Do NOT use adapters, which will increase SWR, with this termination. If adapters are used, the results will be degraded.

2. Remove the 40-dB attenuator and connect the crystal detector directly to the auxiliary output arm.

3. Run a trace on the X-Y Recorder. If the trace stays below the calibration trace, the directivity signal plus the reflection signal from the load is 40-dB down. If not, the coupler could still be good, depending upon the termination SWR. For a termination with a SWR of 1.005 and a 40-dB directivity signal, the resultant could be as low as 38 dB. At Hewlett-Packard, selected loads are used to ensure that the coupler is within specifications. See IMPORTANT NOTE in performance test introduction.

Turn the coupler end-for-end and repeat the test on the other half of the coupler.

PERFORMANCE TESTS (cont'd)

PRIMARY-LINE SWR.

SPECIFICATION:

≤1.15 (774D and 775D).

Note

To test a 774D use another good 774D as the directional coupler in Figure 8. To test a 775D use a good 775D.

Swept-Frequency Test:

DESCRIPTION:

SWR is measured by measuring return loss with a leveled source. As with any reflectometer, first calibration is performed by reflecting all of the signal. Then the 774D/775D under test is connected and the SWR measured.

From a reflectometer calculator, obtainable free from any Hewlett-Packard office listed at the end of this note, we find that an SWR of 1.15 equals a return loss of 23.1 dB. However, with the ambiguity of 40 dB couplers, we must test for a return loss of 24.5 dB or greater to be sure of an SWR of 1.15.

a. Connect the equipment as at (1) in Figure 8.

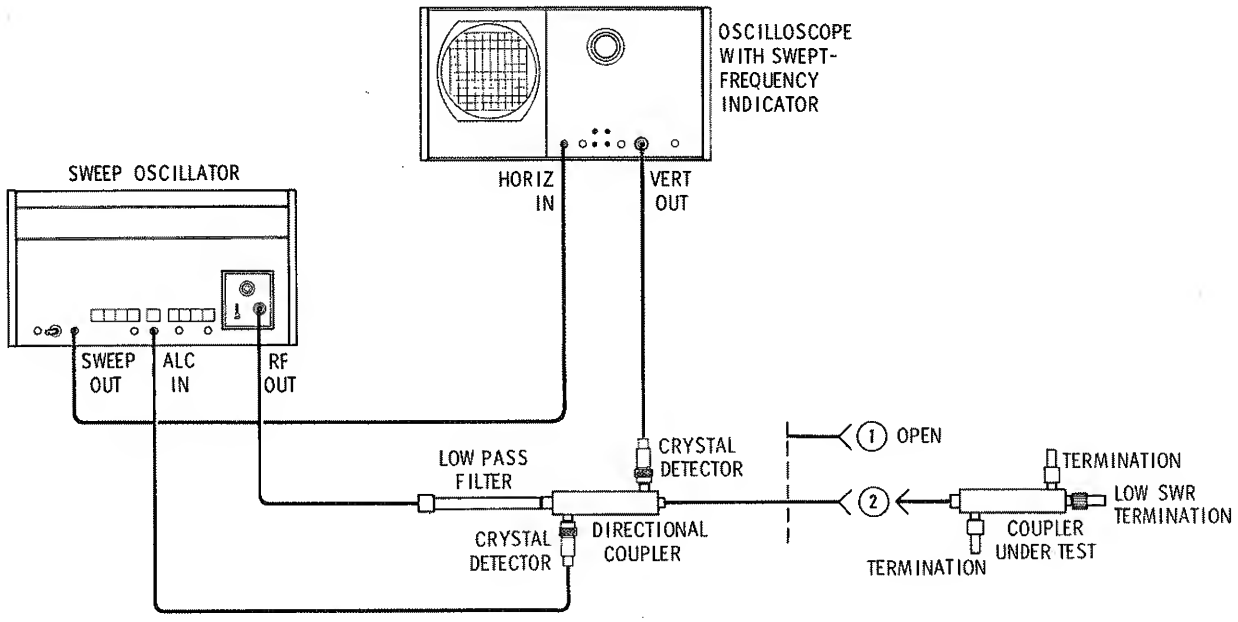


Figure 8. Swept-Frequency Primary-Line SWR Test Setup

EQUIPMENT:

Sweep Oscillator	HP Model 8350B with HP Model 83522A
Low-Pass Filter	HP Model 360A,B
Crystal Detector (2)	HP Model 432A
Directional Coupler	HP Model 774D, 775D (see note above)
Oscilloscope	HP Model 141T with 1416A
Termination (3)	HP Model 909A, Opt. 012

PERFORMANCE TESTS (cont'd)

PROCEDURE:

Calibration:

b. To calibrate, proceed as follows:

1. Set sweep oscillator to sweep over the band of interest with automatic sweep.

2. Set sweep oscillator for leveled output.

3. With 5 dB/cm or more sensitive setting on the oscilloscope, obtain a trace. Mark this trace with a grease pencil. This is the calibration line.

Measurement:

c. To measure the primary-line SWR, proceed as follows:

1. Connect the dual-directional coupler under test as shown at (2) in Figure 8.

2. Increase the gain on the swept-frequency indicator by 24.5 dB.

3. Observe the trace. The test trace should be below the calibration line at all frequencies. If so, the coupler is in specifications without question at all frequencies. If the test trace is above the calibration line the coupler may or may not be within specifications (directivity signal may be adding). To determine if the coupler is within specifications, test at the frequency in question on a fixed-frequency basis. The fixed-frequency test follows.

d. If the coupler is within specifications, turn coupler end-for-end and repeat the test on the opposite port.

PERFORMANCE TESTS (cont'd)

Fixed-Frequency Test:

DESCRIPTION:

This fixed-frequency SWR test should be used when the coupler does not meet the swept-frequency test or when the equipment for swept-frequency testing is not available. The setup used is the standard method of measuring SWR with a slotted line and SWR Meter.

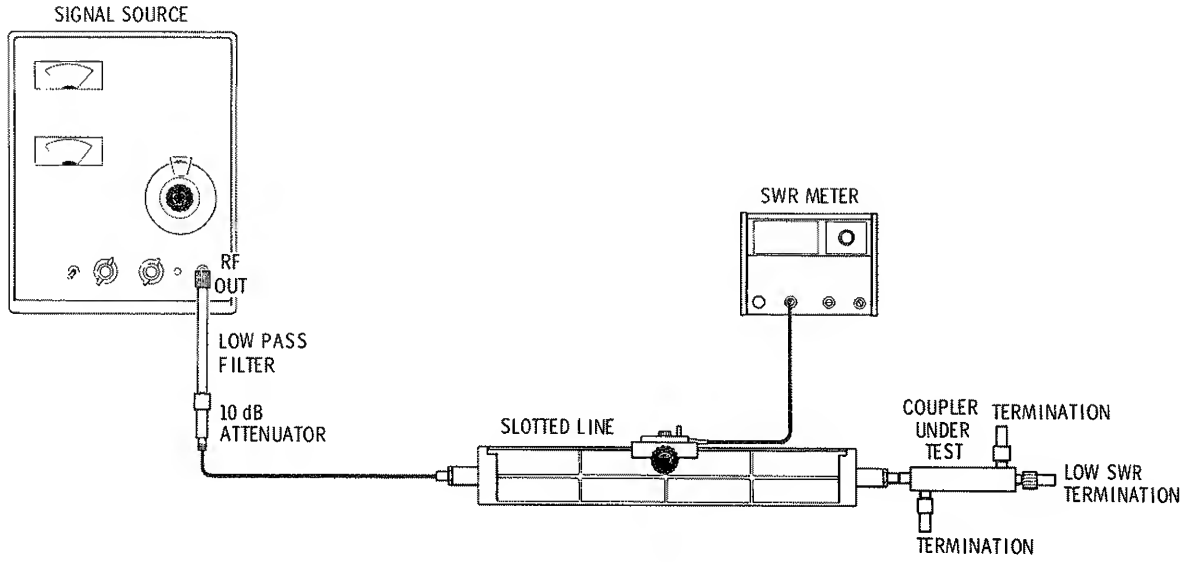


Figure 9. Fixed-Frequency Primary-Line SWR Test Setup

EQUIPMENT:

Signal Source	HP Model 8350B with HP Model 83522A
Attenuator	HP Model 8491A, B
Slotted Line	HP Model 805C
SWR Meter	HP Model 415E
Terminations (2)	HP Model 909, Option 012
Low SWR Termination	HP Model H02-909A (type N male); H03-909A (type N female)

PROCEDURE:

a. Connect the equipment as shown in Figure 9.

b. Set signal source for a 1 kHz squarewave-modulated signal at the frequency in question.

c. Set SWR Meter to HIGH XTAL input impedance and obtain a reading.

d. Peak reading by adjusting modulation frequency of signal source or frequency control of SWR Meter.

e. Set any convenient reference on the SWR Meter 40-dB NORMAL scale.

f. Slide slotted-line carriage to a minimum SWR indication (maximum meter deflection) as near the center of the slotted line as possible.

g. Switch SWR Meter to EXPAND scale, 0-dB range, and set to 1.0 reading on SWR scale.

h. Slide slotted-line carriage to a maximum SWR indication (minimum needle indication) and read meter. If reading is not 1.15 or less, try different low-SWR terminations and try testing other couplers before rejecting the coupler under test.

PERFORMANCE TESTS (cont'd)

AUXILIARY ARM SWR.

SPECIFICATION: ⩽1.2 (774D and 775D)

Swept Frequency Test:

DESCRIPTION: Same as for primary-line SWR.

NOTE

To test a 774D use another good 774D as the directional coupler in Figure 10. To test a 775D use a good 775D.

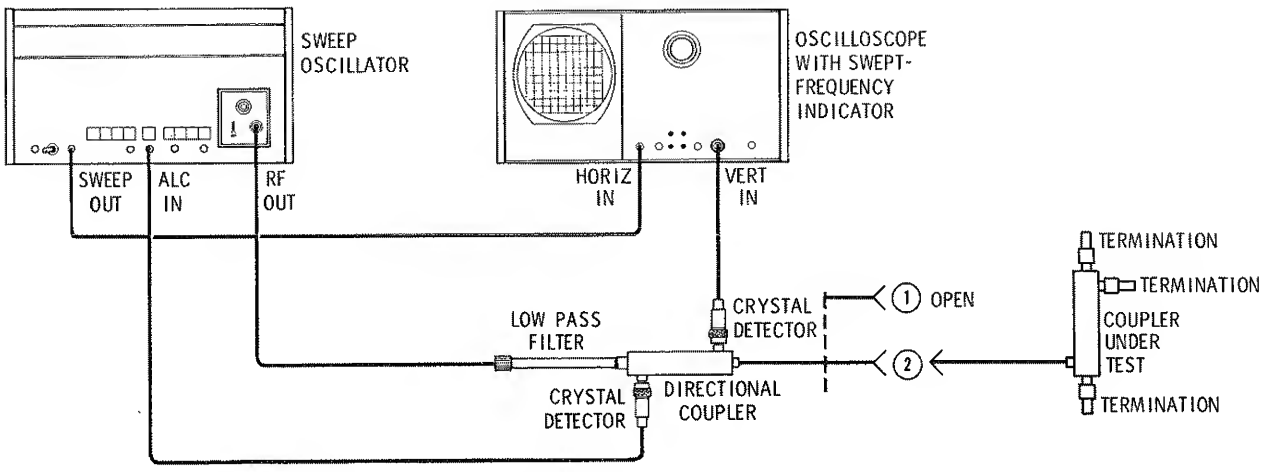


Figure 10. Swept-Frequency Auxiliary Arm SWR Test Setup

EQUIPMENT:

Sweep Oscillator	HP Model 8350B with HP Model 83522A
Low-Pass Filter	HP Model 360A,B
Crystal Detector (2)	HP Model 423A
Directional Coupler	HP Model 774D, 775D (see note above).
Oscilloscope	HP Model 141T with 1416A
Termination(3)	HP Model 909, Option 012

PROCEDURE:

a. Connect the equipment as shown at (1) in Figure 10.

Calibration:

b. To calibrate proceed as follows:
   1. Set the sweep oscillator to sweep over the band of interest with automatic sweep.
   2. Set sweep oscillator for leveled output.
   3. With 5 dB/cm or more sensitive setting on the oscilloscope, obtain a trace. Mark this trace with a grease pencil. This is the calibration trace.

Measurement:

c. To measure the auxiliary-arm SWR proceed as follows:
   1. Connect the 774D or 775D under test as shown at (2) in Figure 10.
   2. Increase the gain on the swept-frequency indicator by 21.9 dB.
   3. Observe the test trace. It should be below the calibration trace at all frequencies. If so, the coupler is within specifications at all frequencies. If test trace is above calibration trace, coupler may or may not be within specifications. Check with following fixed-frequency test.

d. If coupler is within specifications, turn end-for-end and repeat measurement on other port.

PERFORMANCE TESTS (cont'd)

Fixed-Frequency Test:

DESCRIPTION:

This fixed-frequency SWR test should be used when the coupler does not meet the swept-frequency test or when the equipment for swept-frequency testing is not available. The setup used is the standard method of measuring SWR with a slotted line and SWR meter.

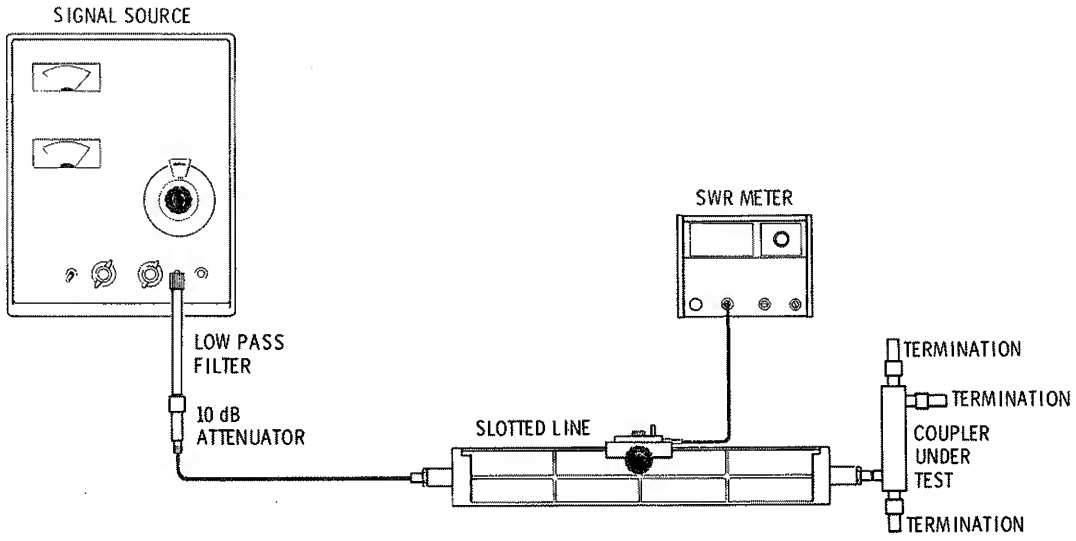


Figure 11. Fixed-Frequency Auxiliary-Arm SWR Test Setup

EQUIPMENT:

Signal Source	HP Model 8350B with HP Model 83522A
Slotted Line	HP Model 805C
SWR Meter	HP Model 415E
Terminations (3)	HP Model 909A
Attenuation	HP Model 8491A,B

PERFORMANCE TESTS (cont'd)

PROCEDURE:

a. Connect equipment as shown in Figure 11.

b. Set signal source for 1 kHz squarewave-modulated CW signal at the frequency in question.

c. Set SWR Meter to HIGH XTAL input impedance and obtain a reading.

d. Peak the reading on SWR Meter either by adjusting modulation frequency of signal source or frequency control on SWR Meter.

e. Set any convenient reference on SWR Meter 40-dB NORMAL scale.

f. Slide slotted-line carriage to a minimum SWR indication (maximum meter deflection) as near the center of the slotted line as possible.

g. Switch SWR Meter to EXPAND scale, 0-dB range, and set to 1.0 reading on SWR scale.

h. Slide slotted-line carriage to a maximum SWR indication (minimum needle indication) and read meter. If reading is not 1.15 or less, try different low-SWR terminations and try testing other couplers before rejecting the coupler under test.

PERFORMANCE TESTS (cont'd)

COUPLING.

SPECIFICATION:

Accuracy of coupling; mean coupling within 0.5 dB of 20 dB
(each secondary arm).
Maximum coupling variation; ±1 dB
(50-ohm terminations).

DESCRIPTION:

Coupling will be tested using a leveled power source with a barretter on a swept-frequency basis. A barretter is used because of the frequency range and its wider square-law range.

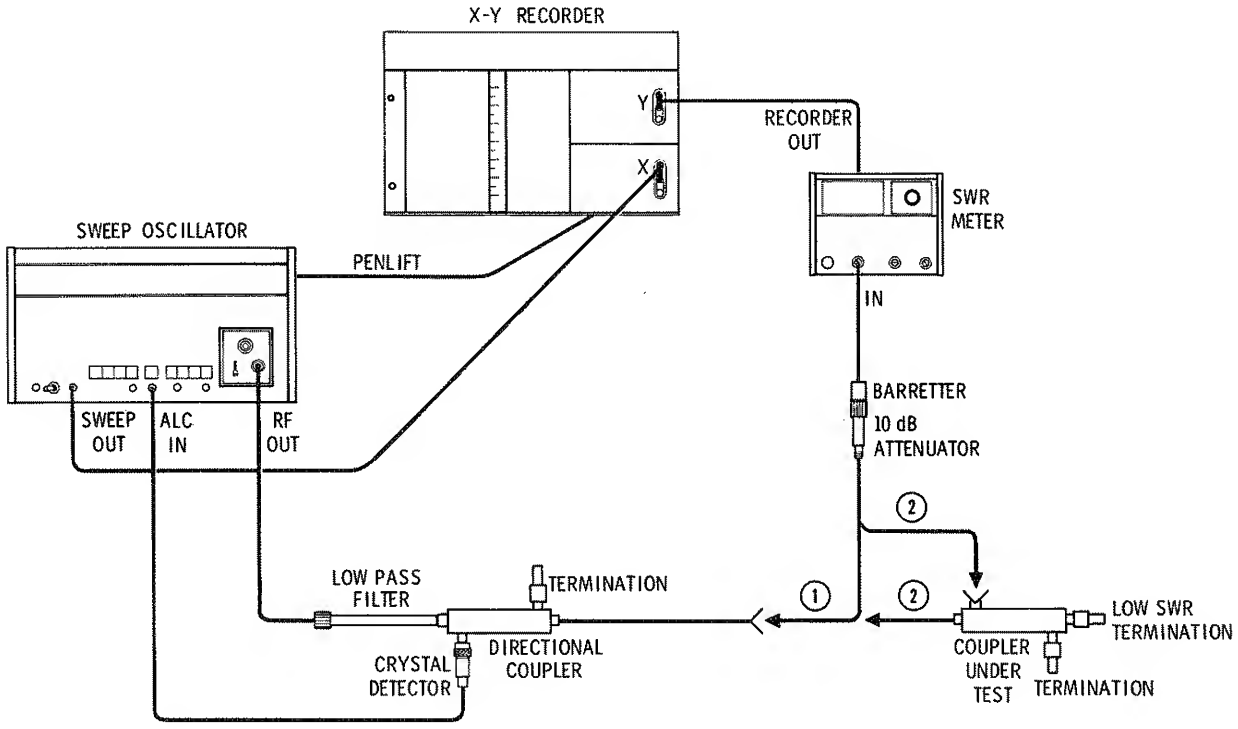


Figure 12. Coupling Test Setup

EQUIPMENT:

Sweep Oscillator	HP Model 8350B with HP Model 83522A
Low-Pass Filter	HP Model 360A,B
Directional Coupler	HP Model 774D for testing 774D HP Model 775D for testing 775D
Crystal Detectors (2)	HP Model 423A
Terminations (2)	HP Model 909A, Opt. 012
Low SWR Termination	HP Model 909A H02-909A (type N male); H03-909A (type N female)
Attenuator	HP Model 8491A,B
Barretter	PRD 627AM
SWR Meter	HP Model 415E
X-Y Recorder	HP Model 7035B

PERFORMANCE TESTS (cont'd)

PROCEDURE:

a. Connect the equipment as shown in (1) in Figure 12.

Calibration:

b. To calibrate the setup, proceed as follows:

1. Set sweep oscillator to sweep band with squarewave modulation.
2. Set sweep oscillator for leveled output.
3. Set SWR Meter to the low (4.5 mA) bolometer input range and for 30-dB sensitivity range.
4. Set sweep oscillator for manual sweep and adjust sweep oscillator internal squarewave-modulation frequency for a maximum reading on SWR Meter. Set sweep oscillator RF out for a reading of 0 dB at some frequency (lowest frequency in band is convenient). Use this same frequency for all subsequent level settings.
5. Manually sweep frequency range with X-Y Recorder pen up and adjust recorder to keep pen holder in upper portion of graph but on the paper.
6. We will now run three traces 1 dB apart to calibrate the vertical scale. Set reading on SWR Meter to 0 dB at lowest frequency. Run a trace. Label this trace 19 dB.
7. Set reading on SWR Meter to 2 dB at lowest frequency. Set pen down and run a trace. Label this trace 21 dB.
8. Set reading on SWR Meter to 1 dB at lowest frequency. Set pen down and run a trace. Label this trace 20 dB. We now have three traces 1 dB apart. Do not change conditions from this setting. We will insert the coupler and measure the deviation from this setting.

Measurement:

c. To make a measurement, proceed as follows:

1. Connect the coupler under test as shown at (2) in coupling test setup, Figure 12. This will insert the nominal 20 dB (down) coupling (attenuation) in the signal path.
2. Set the RANGE switch on the SWR Meter to the 50-dB range. This increases the gain back to the calibration conditions.
3. Run a trace. This is the coupling curve or how the coupler varies from exactly 20 dB of attenuation.
4. Referring to definitions in Figure 1, measure accuracy of coupling (mean coupling) and the maximum coupling variation by using the distance between any two adjacent calibration traces *on a vertical line* as a 1-dB scale. Specification limits are given at the beginning of the test.

Turn coupler end-for-end and test other half of coupler.

PERFORMANCE TESTS (cont'd)

INSERTION LOSS.

SPECIFICATION: 774D ≤0.3 dB, 775D ≤0.4 dB

NOTE

To test a 774D use another good 774D as the directional coupler in Figure 13. To test a 775D use a good 775D.

DESCRIPTION:

Insertion loss will be measured on a swept-frequency basis using an SWR Meter and an X-Y Recorder. For calibration two traces will be run, a 0 dB trace and an insertion-loss limit trace. The coupler under test will then be inserted and a test trace run. The test trace should lie between the two calibration traces.

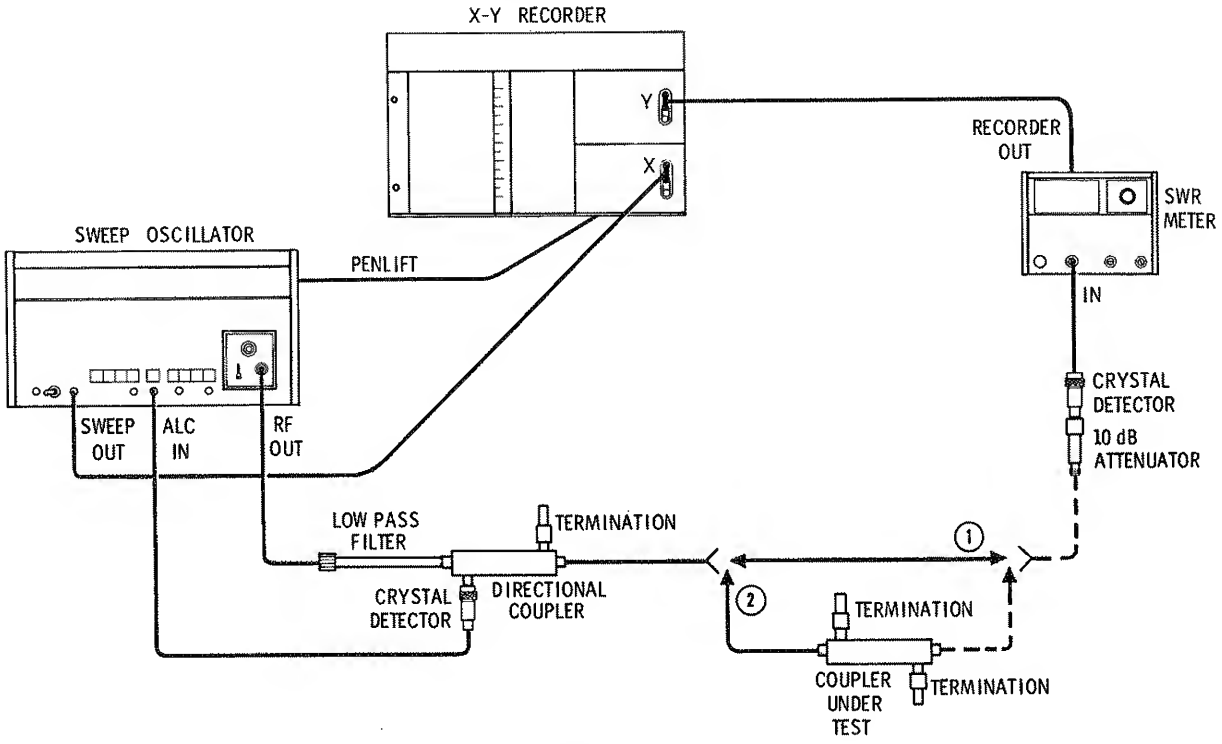


Figure 13. Insertion Loss Test Setup

EQUIPMENT

Sweep Oscillator	HP Model 8350B with HP Model 83522A
Low-Pass Filter	HP Model 360A,B
Crystal Detector (2)	HP Model 423A
Directional Coupler	HP Model 774D, 775D (see note above)
Termination (3)	HP Model 909A, Opt. 012
SWR Meter	HP Model 415E
X-Y Recorder	HP Model 7035B
Attenuator	Model 8491A, Option 010

PROCEDURE:

a. Connect the equipment as at (1) in Figure 13.

b. To calibrate the setup proceed as follows:

1. Set sweep oscillator to sweep over the band of interest with automatic sweep and squarewave modulation.
2. Set sweep oscillator for leveled output over the frequency band of interest.
3. Set SWR Meter to high-impedance crystal input and to 30 dB or more sensitive range.

PERFORMANCE TESTS (cont'd)

4. Set sweep oscillator to lowest frequency in band with manual sweep.

5. Adjust sweep oscillator RF output for a reading on SWR Meter and adjust sweep oscillator internal squarewave frequency control for a peak reading on the SWR Meter.

6. Adjust reading on SWR Meter to be 0.3 dB for 774D or 0.4 dB for 775D (this reading is maximum insertion-loss limit for coupler being tested).

7. Manually sweep frequency and adjust X-Y Recorder controls to keep pen holder on paper.

8. Set X-Y Recorder pen down and record a trace. This is the insertion-loss limit trace.

9. Set SWR Meter to 0.0 dB at lowest frequency in band and run a trace. This trace is the 0 dB baseline.

Measurement:

c. To make a measurement proceed as follows:

1. Connect the coupler under test as shown at (2) in Figure 13.

2. Run a trace. This is the insertion-loss trace. This trace should fall between the baseline and calibration traces.

Table 3. Performance Test Record

Model 77_D Tested by _____

Dual-Directional Coupler Date _____

Serial Number _____ _____

Directivity _____ dB (≥40 dB)

SWR

Primary Line _____ (≥22 dB return loss)

Auxiliary Arm _____ (≥19.9 dB return loss)

Coupling:

Mean coupling _____ dB (20 ± 0.5 dB)

Maximum coupling variation _____ dB (± 1 dB)

Insertion Loss:

774D _____ dB (<0.3 dB)

775D _____ dB (<0.4 dB)

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

HEWLETT-PACKARD SERVICE OFFICES

To obtain servicing information, contact the nearest Hewlett-Packard Sales and Service Office in HP Catalog, or contact the nearest regional office listed below.

UNITED STATES

NO. CALIFORNIA (San Francisco Area)
333 Logue Ave.
Mt. View, CA 94043

SO. CALIFORNIA (Los Angeles Area)
Instrument Repair Center
1421 S. Manhattan Ave.
Fullerton, CA 92631

GEORGIA
450 Interstate N. Parkway
Atlanta, GA 30348

ILLINOIS
5201 Tollview Dr.
Rolling Meadows, IL 60008

NEW JERSEY
W. 120 Century Rd.
Paramus, NJ 07652

AUSTRALIA

Hewlett-Packard Australia Ltd.
31-41 Joseph Street
Blackburn, Victoria 3130

CANADA

Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
Mississauga, Ontario
Canada L4V 1M8

ITALY

Hewlett-Packard Italiana S.p.A.
Via G. Di Vittorio, 9
20063 Cernusco
Sul Naviglio (MI)

FRANCE

Hewlett-Packard France
Quartier de Courtaboeuf
Boite Postale No. 6
F-91401 Orsay Cedex

GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Bernerstrasse 117
Postfach 560 140
D-6000 Frankfurt 56

NETHERLANDS

Hewlett-Packard Benelux N.V.
Van Heuven Doedhartlaan 121
P.O. Box 667
NL-Amstelveen 1134

UNITED KINGDOM

Hewlett-Packard Ltd.
King Street Lane
GB-Winnersh, Wokingham
Berks, RG11 5AR

AFRICA, ASIA, CENTRAL AND SOUTH AMERICA

Hewlett-Packard Intercontinental
3200 Hillview Avenue
Palo Alto, CA 94304

HEWLETT PACKARD

HP Part No: 00774-90009

Printed in U.S.A.